

CS 60050

Machine Learning

Introduction

Some slides taken from course materials of Andrew Ng and P. Domingos

Logistics

- Instructor: Saptarshi Ghosh
 - Email: saptarshi@cse.iitkgp.ernet.in
 - Office: CSE Department, room 305
- Class hours (attendance is compulsory)
 - Monday 12:00 – 12:55
 - Tuesday 10:00 – 10:55, 11:00 – 11:55
- Course Website:
<http://cse.iitkgp.ac.in/~saptarshi/courses/ml2018spring/>

Evaluation

- Mid-semester exam (20%)
- End-semester exam (40%)
- Assignments (40%)
 - 3-4 in number
 - Involving programming or theory

Text & Reference Materials

- R. Duda, et al., **Pattern Classification**, Wiley
- T. Mitchell, **Machine Learning**, McGraw-Hill
- C. Bishop, **Pattern Recognition and Machine Learning**, Springer
- Many resources available freely on Web

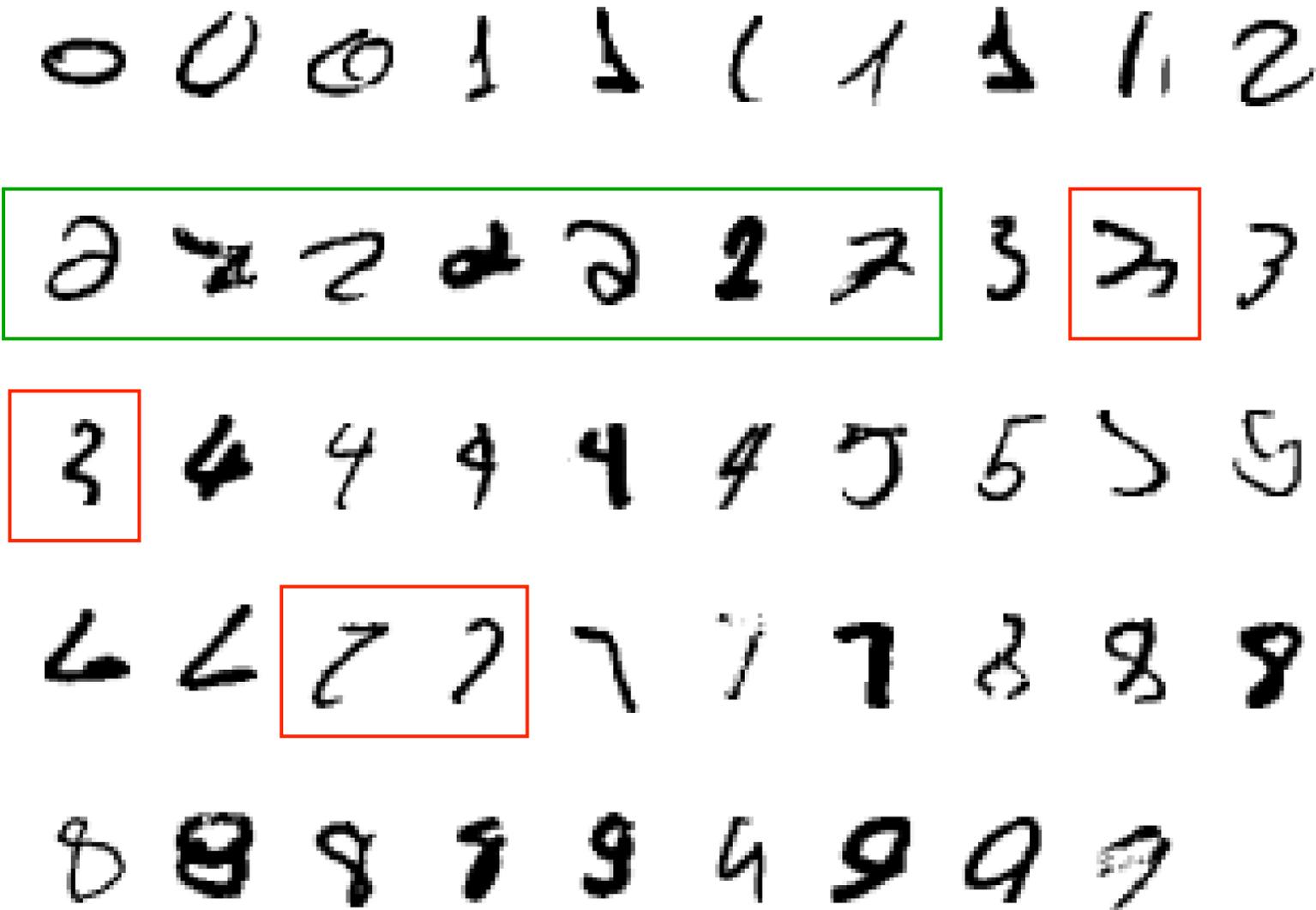
A Few Quotes

- “A breakthrough in machine learning would be worth ten Microsofts” (Bill Gates, Chairman, Microsoft)
- “Machine learning is the next Internet” (Tony Tether, Director, DARPA)
- Machine learning is the hot new thing” (John Hennessy, President, Stanford)
- “Web rankings today are mostly a matter of machine learning” (Prabhakar Raghavan, Dir. Research, Yahoo)

Motivation for ML

- It is hard to write programs for certain tasks
 - Human face or handwriting recognition
 - Playing complex games like chess
 - Recommending movies that a person will like
- Why?
 - We do not ourselves know how to solve
 - Program will be too complicated
 - Too many instances of the program needed

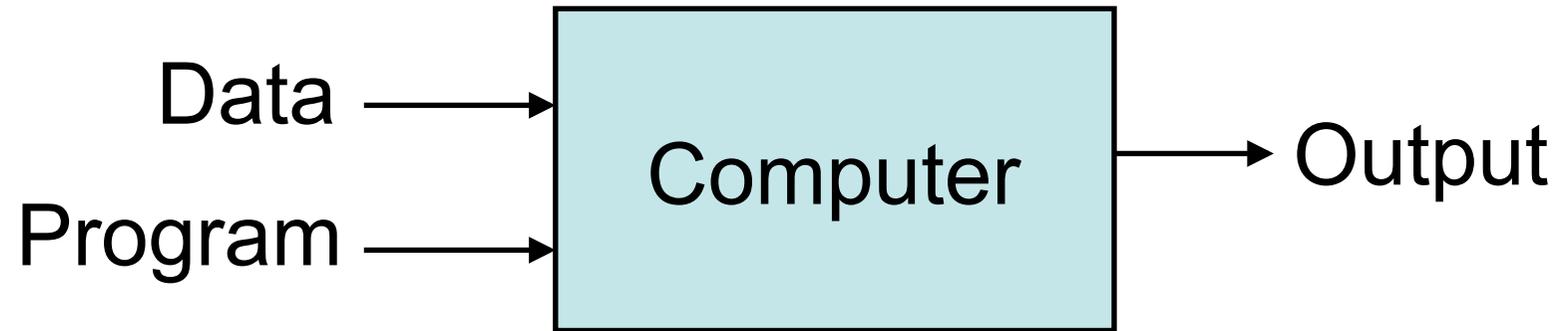
A classic example of a task that requires machine learning: It is very hard to say what makes a 2



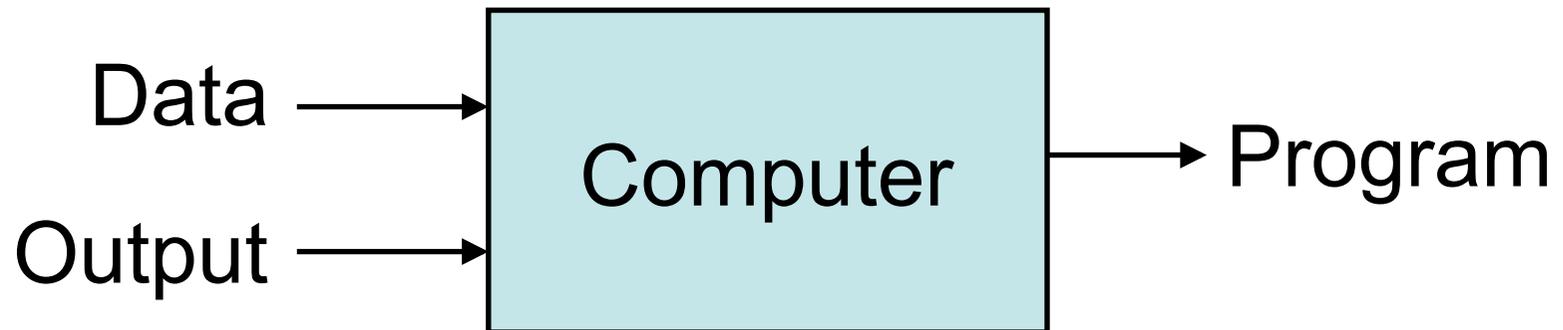
Motivation for ML

- Instead of writing a program by hand, collect lots of examples that specify the correct output for a given input.
- A machine learning algorithm takes these examples and produces a program that does the job.
- If done right, the program works for new cases as well as the ones we trained it on.

Traditional Programming



Machine Learning



Machine Learning definition

- Arthur Samuel (1959):

Field of study that gives computers the ability to learn without being explicitly programmed.

- Tom Mitchell (1998):

Well-posed Learning Problem: A computer program is said to *learn* from experience E with respect to some task T and some performance measure P , if its performance on T , as measured by P , improves with experience E .

Some more examples of tasks that are best solved by using a learning algorithm

- Recognizing patterns
 - Facial identities or facial expressions
 - Handwritten or spoken words
 - Medical images
- Generating patterns
 - Generating images or motion sequences
- Recognizing anomalies
 - Unusual sequences of credit card transactions
 - Unusual patterns of sensor readings in a nuclear power plant or unusual sound in your car engine.
- Prediction
 - Future stock prices or currency exchange rates

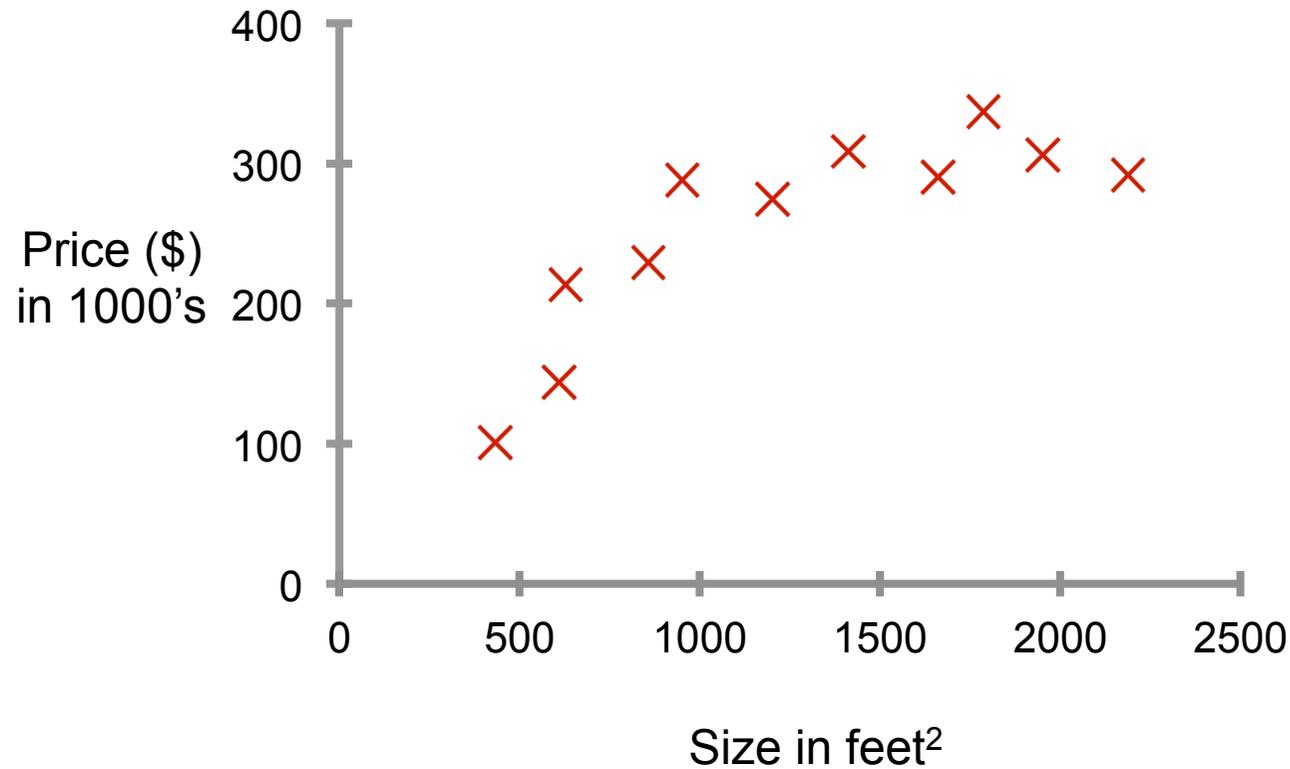
Some web-based examples of machine learning

- The web contains a lot of data. Tasks with very big datasets often use machine learning
- Spam filtering, fraud detection
 - The enemy adapts so we must adapt too.
- Recommendation systems
 - Need to adapt to millions of individuals. Million dollar prize!
- Information retrieval
 - Find documents or images with similar content.
- Data Visualization
 - Display a huge database in a revealing way

Types of Learning

- **Supervised (inductive) learning**
 - Training data includes desired / correct outputs
- **Unsupervised learning**
 - Training data does not include desired outputs
 - Semi-supervised learning: Training data includes a few desired outputs
- **Reinforcement learning**
 - Rewards from sequence of actions

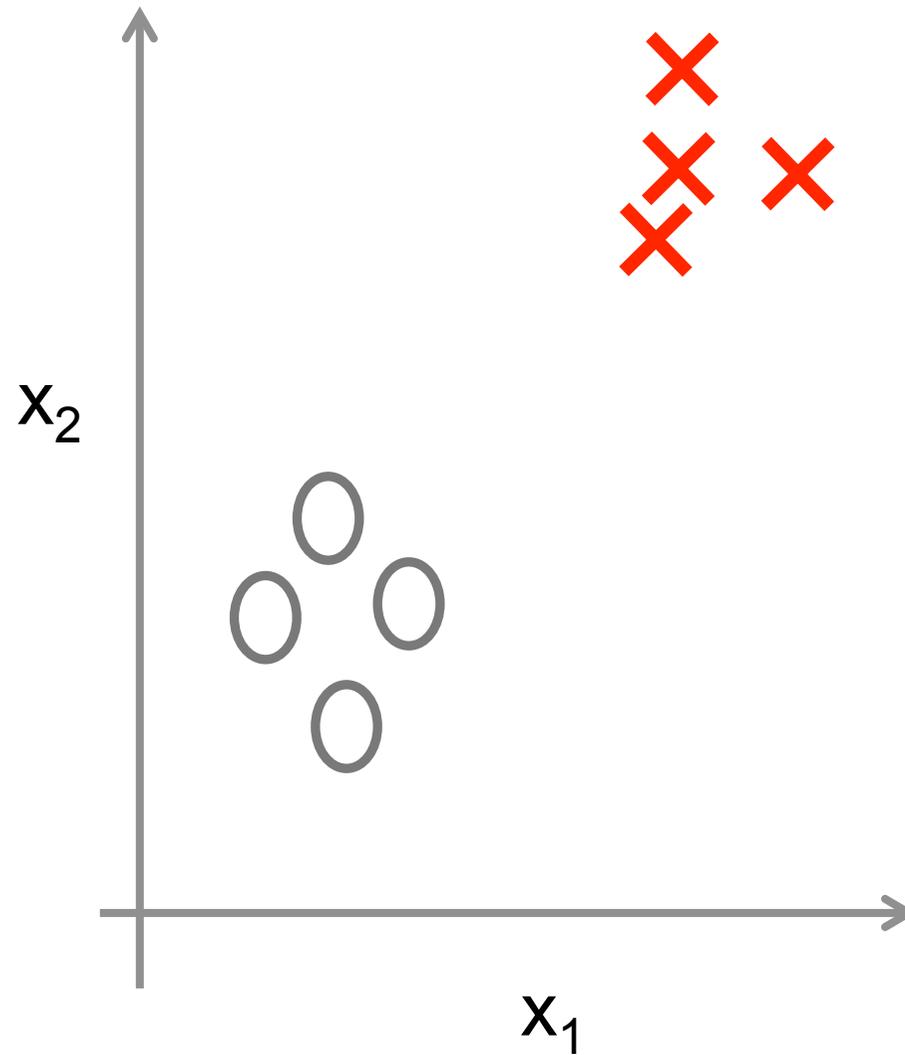
Housing price prediction.



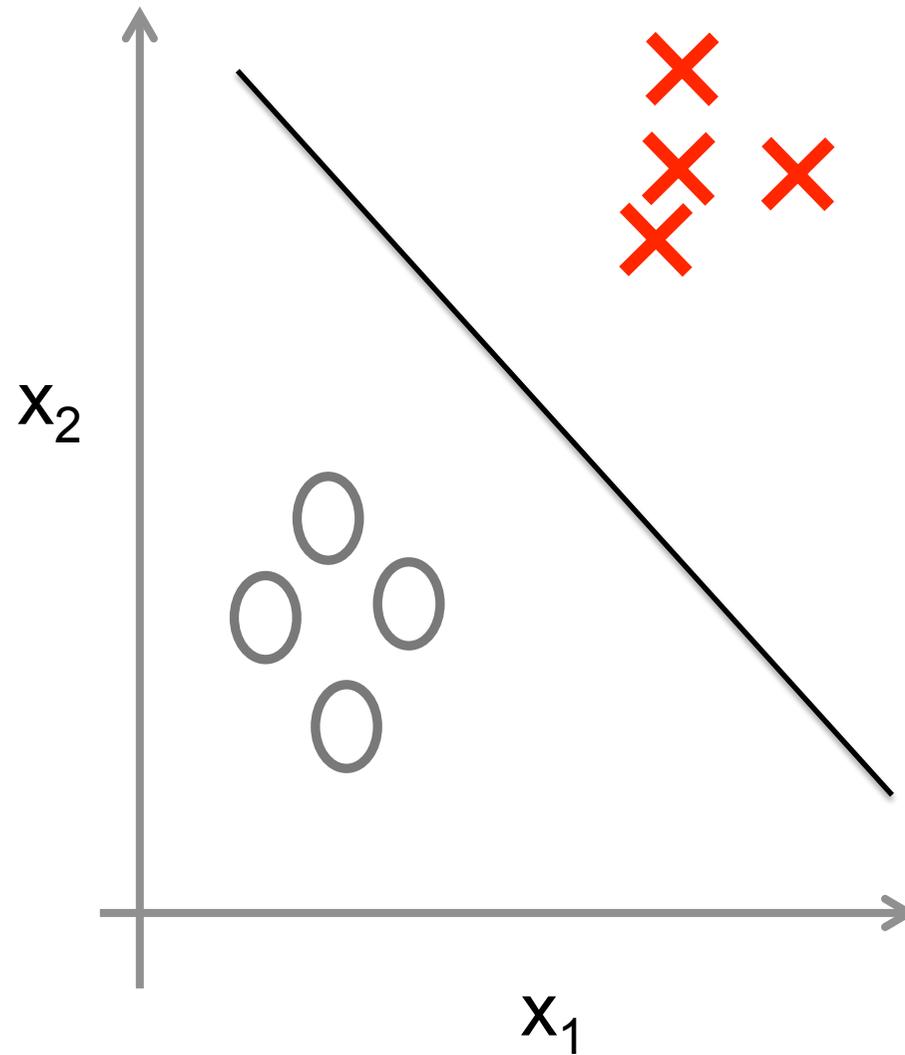
Supervised Learning
“right answers” given

Regression: Predict
continuous valued output
(price)

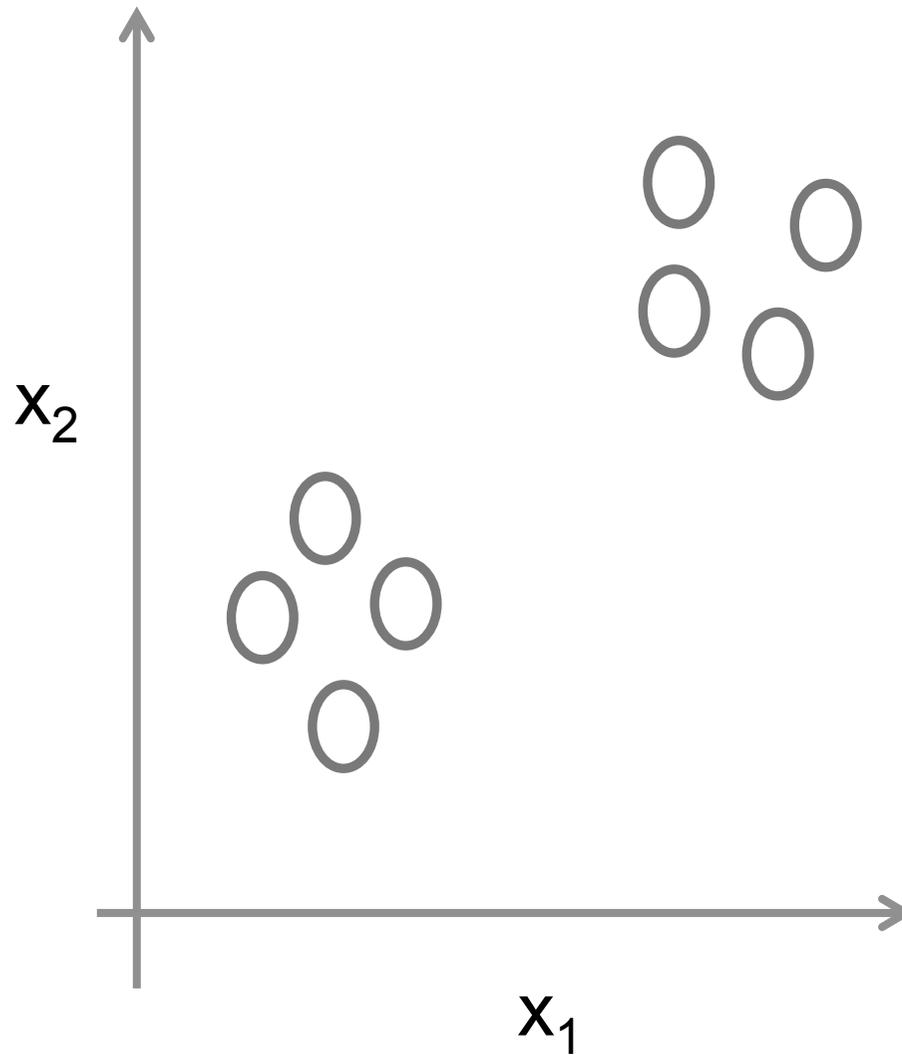
Supervised Learning: Classification



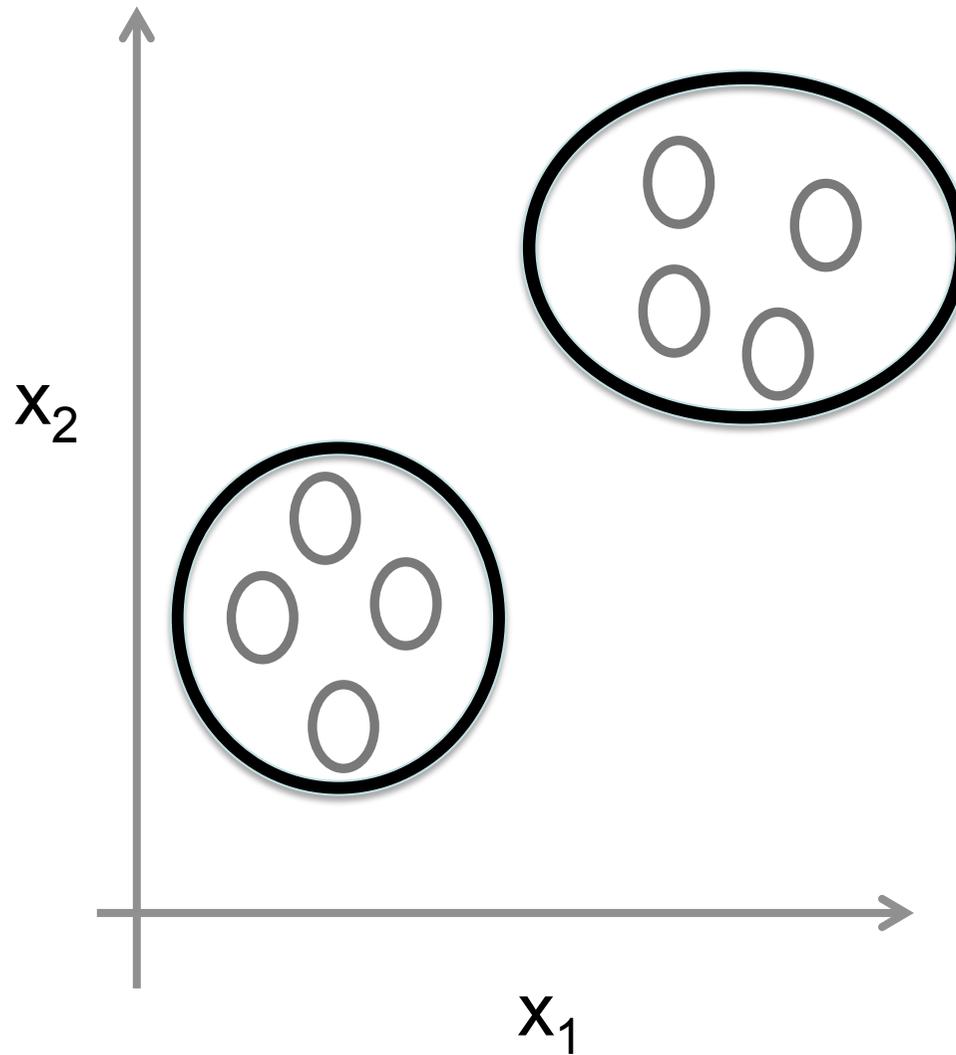
Supervised Learning: Classification



Unsupervised Learning: Clustering



Unsupervised Learning: Clustering



Google News browser window showing news articles. The page includes a navigation bar with links like Web, Images, Videos, Maps, News, Shopping, Gmail, and more. The main content area features several news stories, with one article about BP Oil Well highlighted in red. The highlighted article is titled "BP Oil Well, Site of National Catastrophe, Dies at One" and includes a video link and a thumbnail image of an oil well. Other articles include "White House official denies Tea Party-focused ad campaign" and "US Stocks Climb After Recession Called Over, Homebuilders Gain". The right sidebar contains sections for "Recent" news and "Spotlight" features.

Top Stories

- Deepwater Horizon
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- Tom Brady
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Top Stories

Christine O'Donnell »
White House official denies Tea Party-focused ad campaign
CNN International - Ed Henry - 1 hour ago
Democratic sources say the White House is not considering an ad campaign tying Republicans to the Tea Party. Washington (CNN) -- A top White House official sharply denied a report that claims President Obama's political advisers are weighing a national ...
Tea Party is misplacing the blame, former President Bill Clinton claims
New York Daily News
GOP tea party backer defends Christine O'Donnell The Associated Press
Atlanta Journal Constitution - Politics Daily - MyFox Washington DC - Salon
all 726 news articles »



CNN Interna...

US Stocks Climb After Recession Called Over, Homebuilders Gain

MarketWatch - Kristina Peterson - 16 minutes ago
NEW YORK (MarketWatch) -- US stocks climbed Monday, gaining speed after a key nonprofit organization officially called the recession over, giving investors a boost of confidence in the gradual economic recovery.
Longest recession since 1930s ended in June 2009, group says
Los Angeles Times
Downturn Was Longest in Decades, Panel Confirms New York Times
Wall Street Journal - AFP - CNN - USA Today
all 276 news articles »



MyFox Phila...

BP Oil Well, Site of National Catastrophe, Dies at One

Vanity Fair - Juli Weiner - 22 minutes ago
The BP oil well, site of the Deepwater Horizon explosion that led to the worst oil spill in US history, died today at one year old.
Video: Blown-out BP Well Finally Killed in Gulf
Weiss Doubts BP Would End Operations in Gulf of Mexico: Video Bloomberg
CNN International - Wall Street Journal (blog) - The Guardian - New York Times
all 2,292 news articles »



Reuters

Recent

- Recession officially ended in June 2009
CNNMoney - Chris Isidore - 39 minutes ago
- Hurricane Igor lashes Bermuda
USA Today - Gerry Broome - 5 minutes ago
- 'Explain what you want from us.' reads front-page editorial
msnbc.com - Olivia Torres - 10 minutes ago

Crisis response: Pakistan floods

San Francisco Bay Area - Edit

- Clorox »
Bay Biz Buzz: Clorox close to selling STP, Armor All
San Jose Mercury News - 48 minutes ago - all 24 articles »
- Google's official beekeeper keeps the company buzzing with excitement
San Jose Mercury News - Bruce Newman - 1 hour ago
- Jon Sylvia »
Martinez man still unconscious as police investigate weekend shooting
San Jose Mercury News - Robert Salonga - 48 minutes ago - all 6 articles »

Spotlight

- Sarkozy rages at EU 'humiliation'
Financial Times - Peggy Hollinger - Sep 16, 2010

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CN International - Ed Henry - 1 hour ago
Democratic sources say the White House is not considering an ad campaign lying Republicans to the Tea Party. Washington (CNN) - A top White House official sharply denied a report that claims President Obama's political advisers are weighing a national...

Tea Party is misplacing the blame, former President Bill Clinton claims
New York Daily News

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Los Angeles Times

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New York Times

Wall Street Journal - AFP - CNN - USA Today
all 276 news articles »

Deepwater Horizon »
BP Oil Well, Site of National Catastrophe, Dies at One
Vanity Fair - Juli Wiener - 22 minutes ago
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Video: Blown-out BP Well Finally Killed in Gulf
The Associated Press

Weiss Doubts BP Would End Operations in Gulf of Mexico: Video
Bloomberg

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San Francisco Bay Area - Edit

Clorox »
Bay Big Buzz: Clorox close to selling STP Armor All
San Jose Mercury News - 48 minutes ago
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Google's official bankruptcy keeps the company buzzing
Wall Street Journal - Bruce Newman - 1 hour ago

Jon Sylvia »
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Sarkozy rages at EU 'humiliation'
Financial Times - Peggy Hollinger - September 20, 2010

BP Kills Macondo, But Its Legacy Lives On

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SEPTEMBER 20, 2010, 12:44 PM GMT

BP Kills Macondo, But Its Legacy Lives On

Article Comments (2)

By James Herron

BP confirmed late Sunday that the Macondo well that leaked almost five million barrels of oil into the Gulf of Mexico has been permanently sealed, but the well will continue to affect BP and the wider oil industry for many years.

The most immediate worry for BP and its shareholders is how the authorities will apportion blame for the spill. BP's own investigation

Fire boat response crews battled the blazing remnants of the offshore oil rig Deepwater Horizon on April 21, 2010.

Most Recent

- Who Needs Plaza II Anyway
- Will Banks Be Forced to Split Retail And Banking Arms?
- Timing of Ratings Award Intriguing
- BP Kills Macondo, But Its Legacy Lives On
- We Already Need a Stimulus to Basel III

edition.cnn.com/2010/US/09/20/gulf.oil.disaster/

EDITION: INTERNATIONAL U.S. MEXICO ARABIC

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Allen: Well is dead, but much Gulf Coast work remains

By the CNN Wire Staff
September 20, 2010 -- Updated 1317 GMT (2117 HKT)

Click to play

What next for Gulf oil spill?

STORY HIGHLIGHTS

(CNN) -- The ruptured Macondo well, a mile under the Gulf of Mexico off the Louisiana coast, has been pronounced dead

BP oil spill cost hits nearly \$10bn

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BP oil spill cost hits nearly \$10bn

BP has set up a \$20bn compensation fund after the Deepwater Horizon disaster, which has so far paid out 19,000 claims totalling more than \$240m

Julia Kollwe
guardian.co.uk, Monday 20 September 2010 08.33 BST
Article history

BP's costs for the Deepwater Horizon disaster have hit \$10bn. Photograph: HoReuters

What we will cover

- **Supervised learning**
 - Linear Regression (single and multiple variable)
 - Classification (logistic regression, decision tree, support vector machines, etc.)
 - Neural networks
- **Unsupervised learning**
 - Clustering
 - Dimensionality reduction
- **Ensemble Learning: Bagging, Boosting**
- **Applications of ML**
- **Recent topics, e.g., fairness and bias in ML**

ML in Practice

- Understanding domain, prior knowledge, and goals
- Data integration, cleaning, pre-processing, selection, etc.
- Feature selection – some features may be sensitive, protected, etc.
- Learning models
- Evaluating and interpreting results
- Consolidating and deploying discovered knowledge
- Loop